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PATENT APPLICATION

MAGNETIC RECORDING MEDIA HAVING ADJUSTABLE COERCIVITY USING MULTIPLE MAGNETIC LAYERS AND METHOD OF MAKING SAME

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MAGNETIC RECORDING MEDIA HAVING ADJUSTABLE COERCIVITY USING MULTIPLE MAGNETIC LAYERS AND METHOD OF MAKING SAME

BACKGROUND OF THE INVENTION

This invention relates generally to magnetic recording media such as magnetic thin film recording disks, and more particularly the invention relates to a method of varying coercivity of a recording medium using a multiple magnetic layer construction.

The magnetic disk drive as used for data storage in computer systems comprises one or more disks having thin film magnetic layers on opposing surfaces for the recording of magnetic data as bits along concentric tracks. Typically, as shown in Fig. 1 the disk comprises a substrate 4 of nickel phosphorus (NiP) or ceramic glass on which a plurality of layers are formed by sputtering in a low pressure inert gas atmosphere. The layers include an optional magnetic seedlayer 6, a nonmagnetic underlayer 8 of either pure chromium (Cr) or a chrome alloy (CrX), covered by a magnetic layer 10 of a cobalt (Co) –based alloy. A protective layer 12 made of sputtered carbon (C) is typically used on top of the magnetic layer and an organic lubricant 14 may be used on top of the protective layer.

Data is recorded in the tracks on the disk surface by either vertical or longitudinal magnetization of the magnetic layer. Coercivity (Hr) is a measure of the magnetic field needed to switch polarization in the magnetic layer for the recording of magnetic data. A high magnetic coercivity is important to improve the recording parametric properties of the media and also to improve robustness against thermal decay of recorded information. The magnetic coercivity is controlled by a number of factors such as underlayer design, deposition conditions, and magnetic alloy selection. However, for a single film stack design, the three main parameters which can be used to enhance or reduce the coercivity are substrate temperature during sputtering (Fig. 2A), underlayer thickness (Fig. 2B), and substrate biasing when depositing the magnetic film (Fig. 2C).

Each of these parameters has limitations. As shown in Fig. 2A, while heater power and substrate temperature can increase coercivity, the remanence (Mrt) or magnetic flux density remaining after removal of applied magnetostrictive force decreases with

temperature. Additionally, excessive heat can crystallize the substrate. Thus, equipment and substrate constraints limit the use of high sputtering temperatures.

In Fig. 2B it will be noted that increasing the thickness of the underlayer asymptotically increases coercivity, while increasing underlayer thickness to raise coercivity also increases media noise. Fig. 2C shows that the use of substrate biasing for coercivity control has a minimal effect.

The present invention is directed to a method of adjusting coercivity which overcomes the limitations in the prior art techniques.

SUMMARY OF THE INVENTION

In accordance with the invention, a method of varying coercivity in the manufacture of a magnetic recording medium comprises the steps of providing a substrate for supporting a magnetic layer, sputtering on the substrate an underlayer having a lattice structure for matching with a magnetic layer lattice structure, sputtering a first magnetic layer on the underlying layer, the first magnetic layer having a first alloy composition, and sputtering at least a second magnetic layer on the first magnetic layer, the second magnetic layer having a second alloy composition different from the first alloy composition in percentage composition or element composition. By varying the relative thickness of the first magnetic layer to the thickness of the two magnetic layers, the coercivity of the multiple magnetic layers can be varied to a desired or optimum value.

In preferred embodiments, the overall thickness of the multiple magnetic layers is the same as the single magnetic layer in the prior art, and the magnetic layers comprise a mixture of cobalt (Co) with one or more other elements.

The invention and objects and features thereof will be more readily apparent from the following detailed description and appended claims when taken with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic illustrating the multiple layers in a conventional thin film recording medium.

Figs. 2A-2C are graphs illustrating the effects of substrate temperature, underlayer thickness, and electric bias on magnetic medium parameters.

Fig. 3 is a schematic of a multi-magnetic layer recording medium in accordance with one embodiment of the invention.

Figs. 4-7 are graphs illustrating the effects of relative magnetic film thicknesses on recording medium parameters in accordance with four embodiments of the invention.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Fig. 3 is a schematic illustrating a magnetic recording medium having multiple magnetic layer thin films for recording data in accordance with a preferred embodiment of the invention. Again, a nickel phosphorus (NiP) or ceramic glass substrate 4 is provided on which a seedlayer 6 is deposited with a chromium (Cr) or chrome alloy (CrX) layer 8 deposited on the seedlayer. In accordance with the invention, two magnetic layers 10-1 and 10-2 are deposited by sputtering with a carbon (C) overcoat 12 and lubricant layer 14 being deposited over the magnetic layers. By using a multiple magnetic layer construction the media coercivity can be altered without changing substrate temperature, underlayer thickness, or substrate biasing as is necessary in the prior art.

Each magnetic layer consists of a magnetic alloy of different composition and intrinsic magnetic properties. When deposited individually under the same conditions, they exhibit different coercivity. When deposited in a multilayer structure, changing the thickness ratio between the two layers (see Figs. 4-7) can modify the coercivity. This can be represented by a thickness fraction Q of the first magnetic layer in the stack to the total multilayer thickness where

$$Q = \frac{t_{Mag1}}{\left(t_{Mag1+}t_{Mag}\right)}$$

Importantly, the coercivity can be modified by varying Q while keeping the remanence, Mrt, constant. While the overall thickness of the multiple magnetic layers can be of the same thickness as a single layer prior art magnetic medium, the thickness of the individual magnetic layers can vary from 2 nm to 50 nm respectively.

The multi-magnetic layer structure can comprise cobalt alloys with different alloying elements including one or more of chromium, platinum, tantalum, boron, niobium, molybdenum, nickel, tungsten, carbon, aluminum, iron, and manganese.

As illustrated in the graphs of Figs. 4-7 for specific embodiments, by changing the relative thicknesses of the magnetic layers a change in coercivity is realized while keeping remanence, deposition conditions, and underlayer thickness constant. An optimum coercivity can be realized solely by the variation in thicknesses of the magnetic layers.

In Fig. 4 the effect of film fraction Q on coercivity (Hr), remanence (Mrt) and coercive squareness (S*) are illustrated for a first layer of Co-20Cr-10Pt-8B and a second layer of Co-22Cr-10Pt-6B. Coercivity is given in kiloOersterd (kOe) while remanence and coercive squareness are given in relative units.

In Fig. 5 the first magnetic layer is Co-20Cr-10Pt-8B and the second layer is Co-26Cr-10Pt-6B, while in Fig. 6 the first magnetic layer is an alloy of Co-20Cr-10Pt-8B and the second layer is Co-20Cr-8Pt-4Ta. In Fig. 7 the first magnetic layer is Co-20Cr-8Pt-4Ta and the second magnetic layer is Co-18Cr-6Pt-3Ta. In each of the figures it will be noted that varying the ratio Q has a significant effect on coercivity with little or no effect on remanence and sharpness.

While the invention has been described with reference to specific embodiments, the description is illustrative of the invention and is not to be construed as limiting the invention. For example, while two magnetic layers are described in each of the embodiments, more than two magnetic layers can be employed. Thus, various modifications and applications may occur to those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims.